

In the Specification

Kindly amend paragraph [0001] as follows:

Technical Field

[0009] ~~The present invention~~ This disclosure relates to a surface-treated steel sheet optimum for use in automobiles, household electric appliances, or building materials. Particularly, ~~the present invention~~ this disclosure relates to an environment-conscious surface-treated steel sheet not containing hexavalent chromium (Cr(VI)) which is likely to adversely affect workers, users, or environments of use during wastewater treatment in manufacturing or handling of products.

Kindly amend paragraph [0004] as follows:

[0004] ~~Accordingly, an object of the present invention is to solve the above-described problems of the conventional techniques and~~ it could be advantageous to provide a surface-treated steel sheet exhibiting excellent corrosion resistance, excellent conductivity, and excellent coating appearance even when the film does not contain a pollution control substance such as hexavalent chromium (Cr(VI)).

Kindly amend paragraph [0005] as follows:

Disclosure of Invention Summary

[0005] ~~The present invention relates to~~ We provide a surface-treated steel sheet comprising:

a steel sheet;

a plating layer provided on at least one of the surfaces of the steel sheet, the plating layer containing at least one metal selected from the group consisting of zinc and aluminum;

a first layer film provided on the surface of the plating layer, the first layer film containing (α) 1 to 2000 mg/m² of silica in terms of SiO₂, (β) a total of 1 to 1000 mg/m² of phosphoric acid groups in terms of P, (γ) a total of 0.5 to 800 mg/m² of at least one metal

selected from the group consisting of Mg, Mn, and Al in terms of a metal element, and (δ) 0.1 to 50 mg/m² of a tetravalent vanadium compound in terms of V; and

a second layer film formed to a thickness of 0.1 to 5 μm on the first layer film and containing a resin (A) having at least one type of functional group selected from the group consisting of OH and COOH groups, and at least one rust-proofing additive (B) selected from the group consisting of the following compounds (a) to (e):

- (a) a phosphate;
- (b) Ca ion-exchanged silica;
- (c) a molybdate;
- (d) silicon oxide; and
- (e) at least one organic compound selected from the group consisting of triazoles, thiols, thiadiazoles, thiazoles, and thiurams.

Kindly amend paragraph [0007] as follows:

[0007] ~~The present invention~~ We also ~~provides~~ provide a surface-treated steel sheet having excellent corrosion resistance, conductivity, and coating appearance, the steel sheet comprising a steel sheet having a zinc-based or aluminum-based coating, a composite oxide film formed as a first layer film on a surface of the steel sheet and containing (α) silica, (β) phosphoric acid and/or a phosphoric acid compound, (γ) at least one metal selected from the group consisting of Mg, Mn, and Al (the metal may be contained as a compound and/or a complex compound), and (δ) a tetravalent vanadium (~~V(VI)~~) (IV) compound, the coating weights of these components being as follows:

- (α) silica: 1 to 2000 mg/m² in terms of SiO₂;
- (β) phosphoric acid and/or a phosphoric acid compound: a total of 1 to 1000 mg/m² in terms of P;

(γ) at least one metal selected from the group consisting of Mg, Mn, and Al: a total of 0.5 to 800 mg/m² in terms of Mg, Mn, and Al; and

(δ) a tetravalent vanadium compound: 0.1 to 50 mg/m² in terms of V; and an organic film formed as a second layer film having a thickness of 0.1 to 5 μm on the first layer film and containing an organic polymeric resin (A) having an OH group and/or a COOH group, and at least one rust-proofing additive (B) selected from the group consisting of the compounds (a) to (e) below in a total of 1 to 100 parts by mass (solid content) relative to 100 parts by mass (solid content) of the resin (A):

- (a) a phosphate;
- (b) Ca ion-exchanged silica;
- (c) a molybdate;
- (d) silicon oxide; and

(e) at least one organic compound selected from the group consisting of triazoles, thiols, thiadiazoles, thiazoles, and thiurams.

Kindly amend paragraph [0008] as follows:

Best Mode for Carrying Out the Invention-Detailed Description

[0008] As a result of intensive ~~research for solving the above-described problems, the inventors~~ research, we found that corrosion resistance can be significantly improved by forming a specified composite oxide film containing a tetravalent vanadium compound as a first layer film on a surface of a steel sheet having a coating containing at least one metal selected from zinc and aluminum, and then forming an organic film as a second layer film on the first layer film, the organic film containing a specified organic polymeric resin and a specified self-healing substance at an appropriate ratio.

Kindly amend paragraph [0009] as follows:

[0009] Details of the present invention and the reasons for limitations will be described below.

Kindly amend paragraph [0012] as follows:

[0012] As the steel sheet having an aluminum-containing coating and used as the base of the surface-treated steel sheet of the present invention, an aluminum-plated steel sheet, an Al-Si alloy plated steel sheet, or the like can be used.

Kindly amend paragraph [0022] as follows:

[0022] Next, the phosphoric acid group as component (β) will be described. In general, the term “acid group” means a residual radical after at least one hydrogen atom replaceable with a metal is removed from an acid molecule. In the present invention, the “phosphoric acid group” means a residual radical after at least one hydrogen atom replaceable with a metal is removed from a phosphoric acid analogue. Such a phosphoric acid analogue represents a phosphorus-containing acid. Examples of the phosphoric acid analogue include a series of acids produced by various degrees of hydration of phosphorus pentoxide, such as condensed phosphoric acids, for example, orthophosphoric acid, metaphosphoric acid, pyrophosphoric acid, tripolyphosphoric acid, and polyphosphoric acid, and phosphorous acids such as phosphorous acid and hypophosphorous acid. More specifically, phosphoric acid and/or a phosphoric acid compound is used as the phosphoric acid group in the present invention. Examples of the phosphoric acid and/or phosphoric acid compound include the above-described phosphoric acid analogues and various salts thereof. These compounds may be used alone or in a mixture of two or more. Examples of salts of orthophosphoric acid include primary phosphates, secondary phosphates, and tertiary phosphates. At least one of the metal salts and the compounds can be mixed as a film component by adding to the film composition.

Kindly amend paragraph [0028] as follows:

[0023] ~~In the present invention, the~~ The tetravalent vanadium compound as component (δ) may include a vanadium compound with another valency as long as the tetravalent vanadium compound is contained as a main component (50 wt% or more). Of course, the content of the tetravalent vanadium compound as component (δ) is preferably as high as possible, and only the tetravalent vanadium compound is more preferably added as component (δ). Preferred examples of the tetravalent vanadium compound include an oxide, hydroxide, sulfide, sulfate, carbonate, halide, nitride, fluoride, carbide, and cyanide (thiocyanide) of tetravalent vanadium, and salts thereof. These compounds can be used alone or in a mixture of two or more. As the tetravalent vanadium compound, a tetravalent vanadium compound produced by reducing a pentavalent vanadium compound using a reducing agent is preferably used from the viewpoint of corrosion resistance and resistance to blackening. In this case, the reducing agent used may be either inorganic or organic, but an organic agent is more preferred.

Kindly amend paragraph [0060] as follows:

[0060] ~~In the present invention, in order to~~ To improve the corrosion resistance of the organic film, a thermosetting resin and a curing agent are preferably mixed. In this case, an amino resin such as an urea resin (e.g. butylated urea resin or the like), a melamine resin (e.g. butylated melamine resin), a butylated urea-melamine resin, a benzoguanamine resin, or the like, block isocyanate, an oxazoline compound, a phenol resin, or the like can be added as the curing agent.

Kindly amend paragraph [0064] as follows:

[0064] ~~In the present invention, the~~ The organic polymeric resin (A) is preferably a product (X) of reaction of a film-forming organic resin with an active hydrogen-containing material (D) entirely or partially comprising a hydrazine derivative (C) having active hydrogen. The active hydrogen-

containing material (D) may be a mixture or a compound. Namely, the active hydrogen-containing material (D) entirely or partially comprises the hydrazine derivative (C) having active hydrogen. In the present invention, the resin (A) (or the organic polymeric resin (A)) is more preferably the reaction product (X) produced by modifying the film-forming organic resin with the active hydrogen-containing material (D), the product (X) corresponding to a modified resin having an OH group and/or COOH group.

Kindly replace paragraph [0067] as follows:

[0067] ~~In the present invention, it~~ It is desired that the hydrazine derivative (C) is introduced to the molecule of the film-forming organic resin (A). Therefore, at least a part (preferably the whole) of the active hydrogen-containing material (D) is composed of the hydrazine derivative (C) having active hydrogen. In the present invention, the active hydrogen can be determined by the presence of reactivity to the resin. For example, hydrogen reactive to an epoxy group can be determined to be active hydrogen.

Kindly replace paragraph [0081] as follows:

[0081] ~~In the present invention, in order to~~ To form the compact barrier film, preferably, the curing agent is mixed in the resin composition, and organic film is heat-cured.

Kindly replace paragraph [0106] as follows:

[0106] ~~In the present invention, the~~ The dry thickness of the organic film must be 0.1 μm to 5 μm , preferably 0.3 μm to 3 μm , and more preferably 0.5 μm to 2 μm . When the thickness of the organic film is less than 0.1 μm , the corrosion resistance is unsatisfactory, while when the thickness exceeds 5 μm , the conductivity degrades.

Kindly replace paragraph [0108] as follows:

[0108] ~~In the present invention, an~~ An appropriate amount of the rust-proofing additive (B) (self-healing substance) is mixed in the organic film comprising the specified organic polymeric resin. As a result, particularly, the excellent rust-proofing ability (self-healing effect) can be obtained. The possible rust-proofing mechanism realized by mixing the components (a) to (e) in the specified organic film is as follows:

Component (a) is dissociated into phosphoric acid ions by hydrolysis in a corrosive environment and forms a protective film due to complex forming reaction with the eluted metal.

Kindly replace paragraph [0118] as follows:

[0118] ~~In the present invention, usable examples~~ Examples of the solid lubricant include the following. These compounds may be used alone or in combination of two or more.

(1) Polyolefin wax and paraffin wax: for example, polyethylene wax, synthetic paraffin, natural paraffin, micro wax, and chlorinated hydrocarbons.

(2) Fluororesin fine particles: for example, polyfluoroethylene resin (polytetrafluoroethylene resin), polyvinyl fluoride resin, and polyvinylidene fluoride resin.

Kindly replace paragraph [0126] as follows:

[0126] The surface-treated steel sheet ~~of the present invention~~ is produced by coating the surfaces of a steel sheet having a zinc-containing or aluminum-containing coating with a treatment solution containing the components for the composite oxide film, heat-drying the steel sheet, coating the steel sheet with a coating composition containing the specified organic polymeric resin (A) and the rust-proofing additive (B) (preferably as main components), and further containing the solid lubricant and the like according to demand, and then heat-drying the coated steel sheet.

Kindly replace paragraph [0134] as follows:

[0134] ~~In the present invention, the~~ The above-described films are formed on one or both of the surfaces of the steel sheet. Therefore, the forms of the steel sheet of the present invention include the following:

- (1) One side: plating film-composite oxide film-organic film, the other side: plating film
- (2) One side: plating film-composite oxide film-organic film, the other side: plating film-known phosphate-treated film
- (3) Both sides: plating film-composite oxide film-organic film
- (4) One side: plating film-composite oxide film-organic film, the other side: plating film-composite oxide film
- (5) One side: plating film-composite oxide film-organic film, the other aide: plating film-organic film

Kindly replace paragraph [0146] as follows:

[0146] As described above, the surface-treated steel sheets ~~of the present invention~~ exhibit excellent corrosion resistance even when coatings do not contain a pollution control substance such as hexavalent chromium, and also have excellent conductivity and coating appearance.

Kindly amend paragraph [0147] as follows:

Industrial Applicability

[0147] The surface-treated steel sheet ~~of the present invention~~ has excellent corrosion resistance, conductivity, and coating appearance without containing a pollution control substance such as hexavalent chromium or the like. Therefore, the surface-treated steel sheet can be applied to a wide range of applications such as automobiles, home electric appliances, building materials, and the like without adversely affecting workers, users, or environments.